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A/C System and Components

Model: All

Production: All

OBJECTIVES

After completion of this module you will be able to:

- Demonstrate the operation of an air conditioning system.
- Identify the different components that make up an air conditioning system.

Air Conditioning System

An air conditioning system does not produce cold but rather it carries heat away from the vehicle interior to the outside. The closed system is filled with a refrigerant called (R12 or R134a) which is circulated and provoked to change state from a liquid to a gas and back again. (R134a has been introduced to replace R12 for environmental reasons.)

The air conditioning system operates in accordance with the compression refrigerating principle, in which the circulating refrigerant is compressed in a gaseous state, condensed into a liquid by dispelling heat and vaporized by rapidly reducing its pressure which causes it to change state to a gas once again while absorbing heat and humidity from the passenger compartment.

The system is comprised the following basic components:

- Compressor
- Condenser
- Condenser fan
- Receiver Dryer/collector
- Expansion valve
- Evaporator
- Hoses and pipes
- Regulation and control devices



E90 A/C System Components

The Refrigerant Cycle

The refrigerant circuit is divided into a high pressure section (high side) and a low pressure section (low side). The high pressure side is comprised of the compressor, condenser, condenser fan, pressure sensor, receiver dryer and expansion valve. The low pressure side also involves the compressor and expansion valve along with the evaporator and blower fan. The expansion valve separates the high-pressure side of the system from the low-pressure side. Pressurized liquid refrigerant exits the receiver dryer and as it passes through the metered orifice of the expansion valve it decompresses and boils.

This change of state causes the refrigerant to absorb heat as it makes its way through the inside of the evaporator. The amount of refrigerant released is controlled by the expansion valve based on evaporator temperature and pressure as well as the temperature of the air passing through the evaporator and proportional to the cooling demand. If too little refrigerant enters the evaporator, poor cooling results. If too much refrigerant enters, it might not completely boil away and liquid refrigerant might return to the compressor, causing damage to the system.

The pressure and temperature are measured by passing the refrigerant through the expansion valve at the outlet of the evaporator. The top section of the valve measures the temperature of the refrigerant intake and the refrigerant pressure acts on the underside of the diaphragm.

The valve controls flow of refrigerant through the evaporator as pressure and temperature of the gaseous refrigerant at the evaporator outlet are used to open and close the valve via a diaphragm.

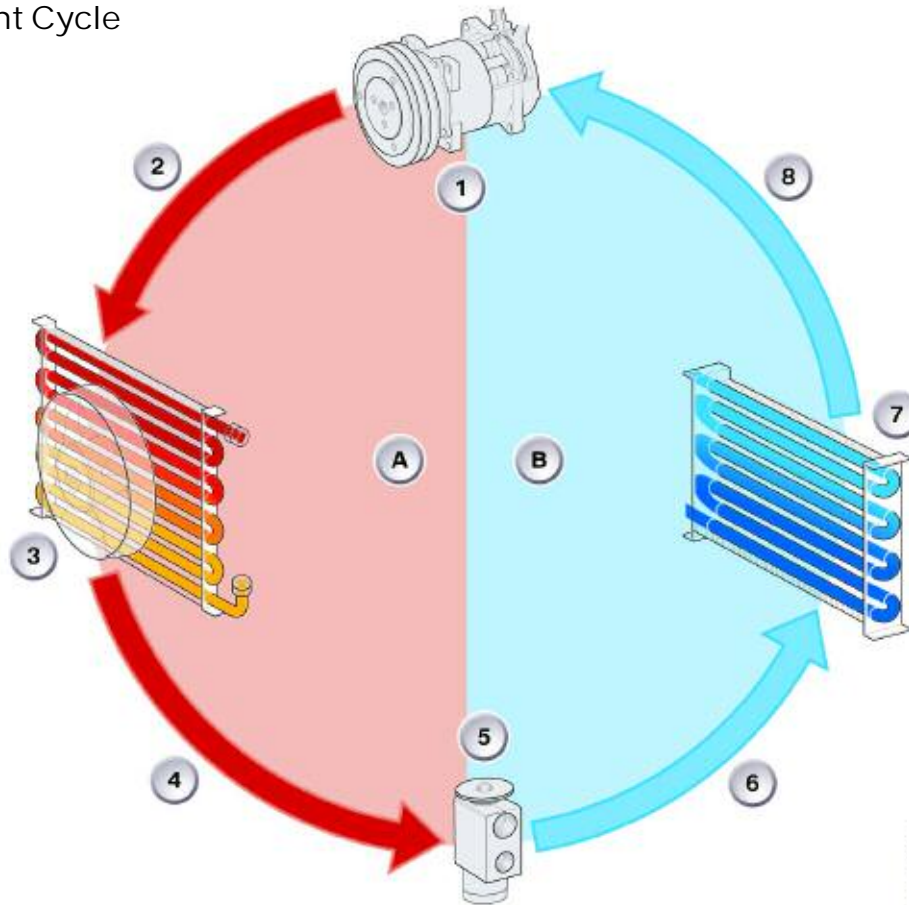
The flow rate is increased and decreased as air temperature at the evaporator output rises and falls. This control procedure runs continuously for as long as the air conditioning system is in operation.

Heat is extracted from the interior as it is circulated by a blower fan through the evaporator outer surface area. This transfers heat from the cabin air to the vaporizing refrigerant within, reiterating that an air conditioning system operates by removing heat instead of adding cold.

An engine driven compressor extracts the gaseous low pressure refrigerant from the evaporator, compresses it and heats it. The now compressed and superheated gas is pumped through the condenser where it cools to a high pressure liquid as outside air is forced through the condenser fins while driving or via the condenser cooling fan.

The refrigerant now in a sub-cooled liquid state flows from the condenser to a liquid reservoir (receiver dryer) where it is collected. Any moisture and impurities are removed by the desiccant in the receiver dryer. This high pressure liquid now flows back into the low pressure side of the system, where it is forced through the expansion valve metered orifice back into the evaporator on its way to complete the cycle once again.

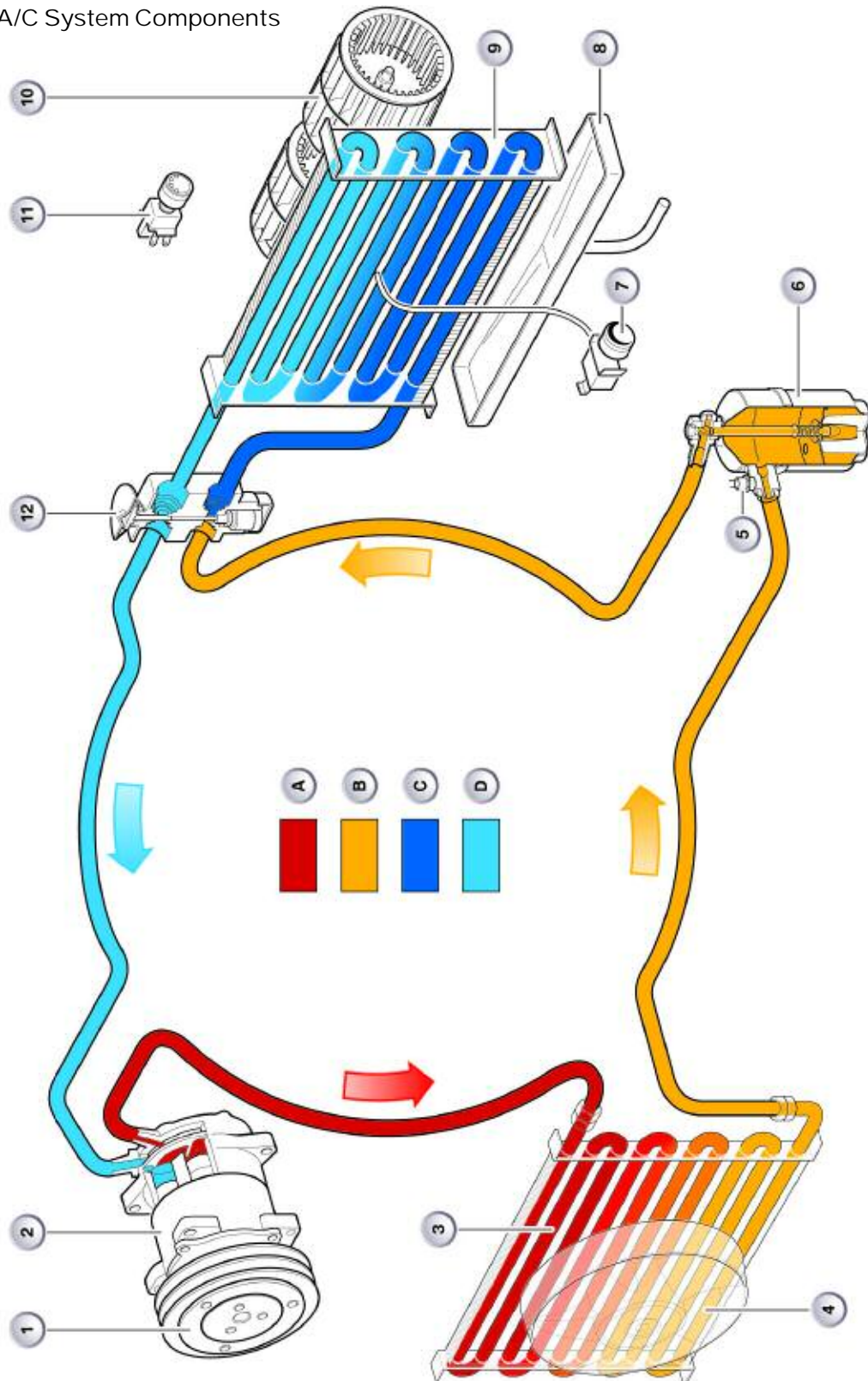
Refrigerant Cycle



Index	Explanation	Index	Explanation
1	The compressor increases the pressure and the temperature of the gaseous refrigerant.	6	Refrigerant in vapor state at low temperature/low pressure.
2	Gaseous refrigerant at high temperature/high pressure.	7	The evaporator dehumidifies the air flow as the cold refrigerant absorbs heat.
3	The condenser functions as a heat exchanger. The air flowing past absorbs heat as the hot refrigerant gas cools down it condenses into a liquid.	8	Gaseous refrigerant at low temperature/ low pressure.
4	Liquid refrigerant at medium temperature/high pressure.	A	High-pressure side
5	The expansion valve relieves the pressure of the refrigerant which induces a large drop in temperature.	B	Low-pressure side

Air Conditioning System Components

Typical A/C System Components



Index	Explanation	Index	Explanation
1	Electric clutch	9	Evaporator
2	Compressor	10	Evaporator blower
3	Condenser	11	Blower Switch
4	Auxiliary fan	12	Expansion Valve
5	Pressure sensor	A	High pressure, gas
6	Liquid Receiver Dryer	B	High pressure , liquid
7	Evaporator temperature sensor	C	Low pressure , liquid
8	Condensation water tray	D	Low pressure, gas

Compressors

Compressors used in air conditioning systems operate based on various principles:

- Reciprocating piston compressor
- Spiral compressor
- Vane-type compressor
- Swash plate compressor

The following description deals with the swash plate compressor (also known as wobbler compressor) as it is the most commonly used in present BMW vehicles.

The swash plate converts the rotary motion of the drive shaft into an axial motion that along with a changing pivot point varies the stroke of the pistons.

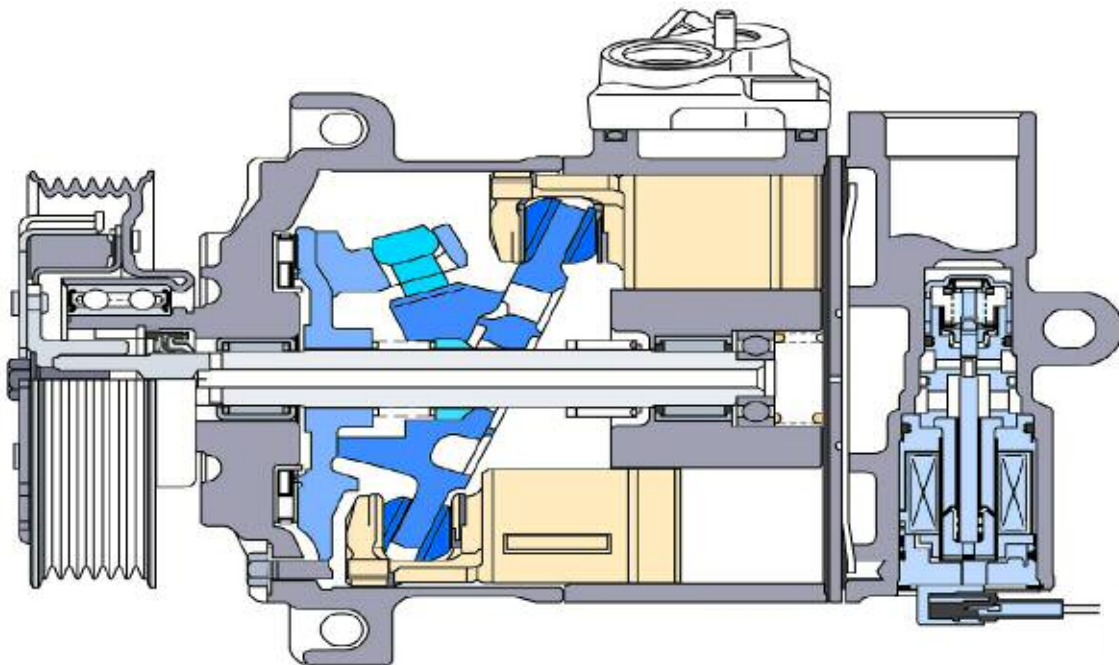
The varying piston stroke delivers a variable cylinder displacement, directly affecting and reacting to the A/C system pressure.

Depending on the design, this may involve 5 to 7 pistons that are arranged in a circle around the drive shaft. An intake/pressure valve is assigned to each piston, these valves open/close automatically in time with the operating cycle.

Seven Piston Swash Compressor Cut-away



Seven Piston Swash Compressor



The design layout of the air conditioning system is set to full load. The output of the compressors, however, depends on the engine speed. Consequently, speed differences of up to 2000 rpm can occur. These fluctuations have an influence on the charge of the evaporator and therefore on the cooling capacity of the air conditioning system.

Output-controlled compressors with variable displacement were developed for the purpose of adapting to different engine speeds, ambient temperatures of interior temperatures selected by the driver. This adaptation is achieved by varying the angle of the swash plate.

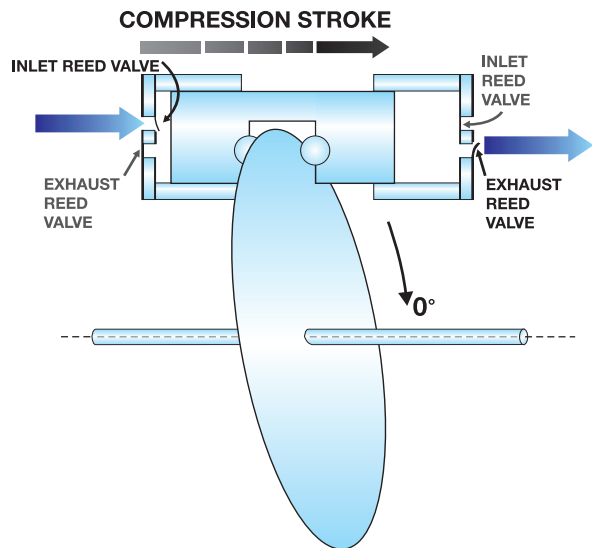
The swash plate is guided in longitudinal direction in a slide rail or runner.

The stroke of the pistons and thus the delivery capacity are determined by varying the inclination of the swash plate.

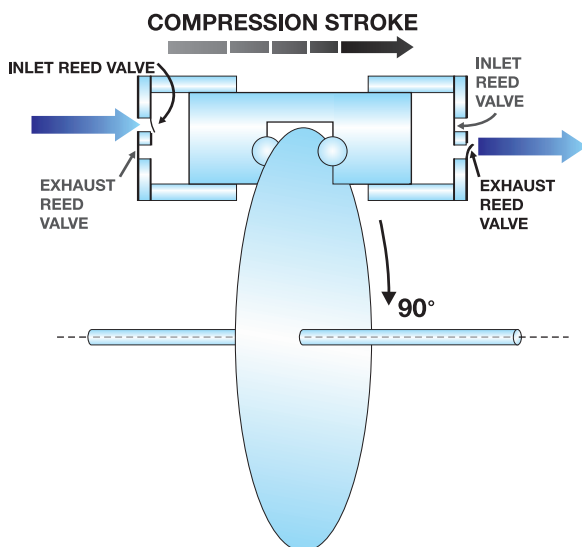
The inclination is dependent on the chamber pressure and therefore on the pressure ratios at the top and bottom of the pistons.

The inclination is supported by springs arranged before and after the swash plate.

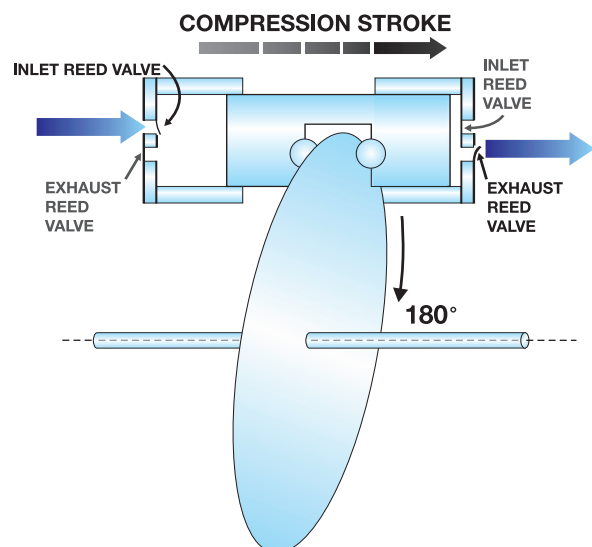
High Displacement

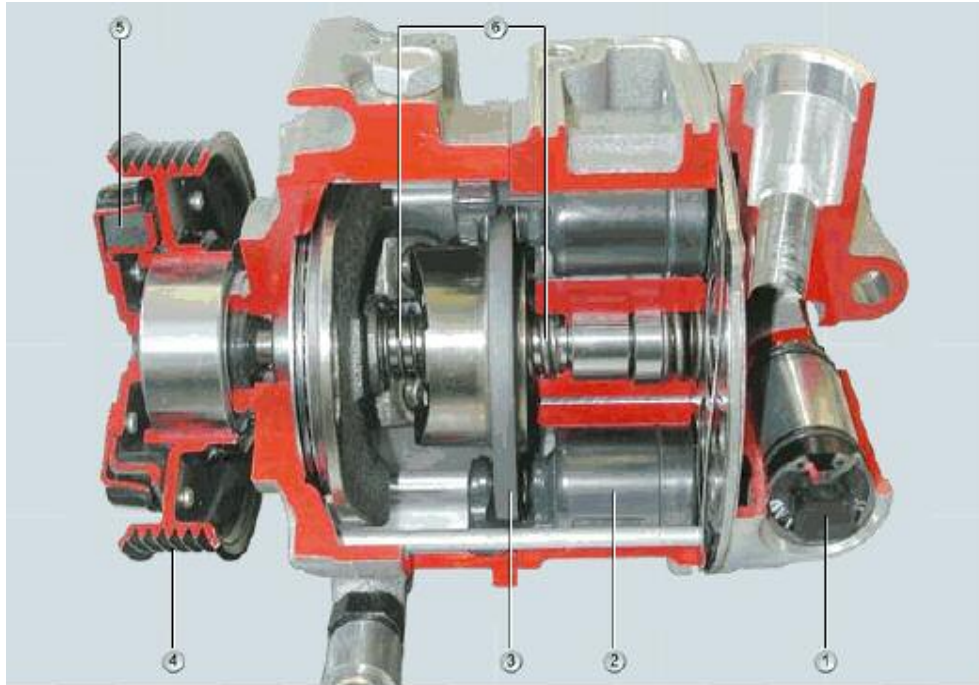


Medium Displacement



Low Displacement





Clutchless Compressor Cutaway

Index	Explanation	Index	Explanation
1	Control Valve Solenoid	4	Pulley with bearing
2	Piston	5	Formed rubber element
3	Swash Plate	6	Control Springs

Features

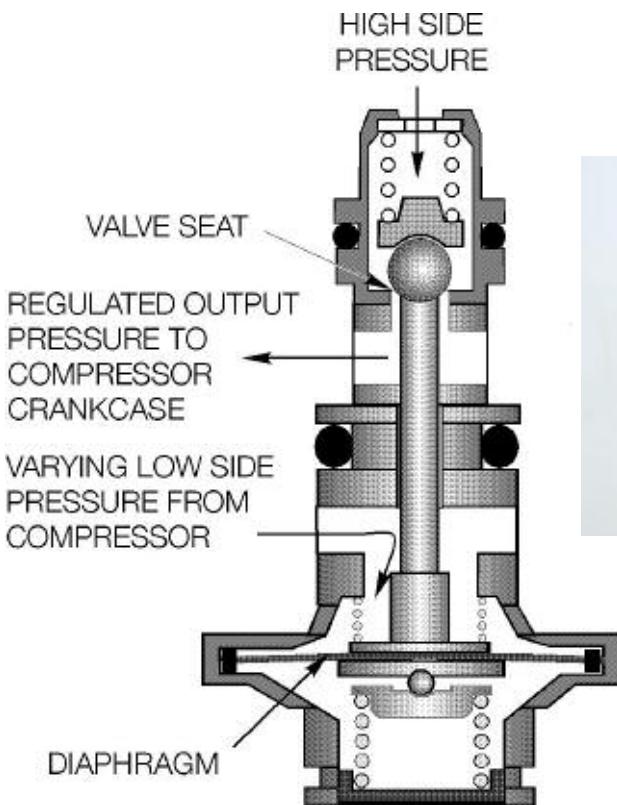
- Current vehicles use a 7 piston-swash plate compressor design.
- Variable displacement volume for adaptation of the required refrigerating capacity.
- Pulley drive with or without magnetic clutch.
- Control valve for controlling the pressure ratio in the compressor.

Compressor Control Valve

Depending on application, the compressor may or may not use a magnetic clutch. In vehicles that use clutchless compressors they are constantly engaged when the engine is running. This results in constant drag on the engine which affects emissions and fuel economy.

The compressor output is always variable displacement and is controlled internally by either a mechanical control valve that operates solely on A/C pressure differential and does not need electronic signals or an electronic control valve that operated directly by signals from the IHKA control module depending on the system demand.

Mechanical Control Valve



Electronic Control Valve



Electronic Control Valve

Function

The control valve in the compressor is controlled infinitely variable by the IHKA control unit. Depending on the ventilation temperature, outside temperature, interior temperature as well as the target and actual evaporator temperature, the pressure in the crankcase of the compressor is varied by means of a pulse-width-modulated voltage signal.

The compressor is driven by constant engagement pulley (Clutchless) and a ribbed V-belt. The inclination of the swash plate changes, determining the displacement volume and therefore the refrigerating capacity. The compressor output capacity and therefore the delivery volume can be set from 0-2% minimum to 100% maximum.

For example, the control unit (IHKA) activates the control valve accordingly when a higher refrigerating capacity is required. A pulse width-modulated voltage signal moves a tappet (plunger) in the control valve. The time the voltage is applied determines the adjustment range. The adjustment varies the opening cross section in the control valve between the high pressure and the pressure in the crankcase.

E70 Compressor Control

The IHKA is the master for controlling the A/C compressor. Pressing the A/C button on the air conditioning system operating unit switches the air conditioning system to the ready state. The IHKA transmits a speed increase request to the DME (ECM).

Depending on the temperature and the nominal-value setting, the IHKA sends a cooling power request to the DME (ECM). If the DME (ECM) is ready and in a position to provide torque of > 20 Nm, the DME (ECM) issues a release for a load connection of up to 30Nm. This release is also monitored by the junction box. The IHKA issues a command to the junction box to couple the connection. The junction box returns the coupling status to the DME (ECM).

The compressor output is controlled by the IHKA control unit by means of an infinitely variable control valve. The IHKA control command is converted into infinitely variable proportional powering of the control valve in the junction box.

The evaporator temperature is controlled to a value of between 2°C and 8°C depending on the cooling power request. The temperature sensor signal in the evaporator is used as a feedback signal to the IHKA control unit. The refrigerant request is limited by the potential evaporating power of the evaporator. The evaporator is prevented from icing up by controlling the compressor output (appropriate reduction).

In order to reduce CO₂ emission, avoid unstable conditions when the engine is idling and for full load acceleration, the DME can activate a compressor shut-off via the junction box. If appropriate parameters are present, the solenoid coupling of the compressor is opened.

K-CAN signals for controlling the A/C compressor at the IHKA control unit

IN/OUT	Signal	Source/sink
OUT	Cooling power request /Torque request	DME Junction box
IN	Release and provision of torque	DME Junction box
OUT	Close coupling	Junction box
OUT	Power control valve	Junction box
IN	Compressor coupling status signal	Junction box

Note: E70 vehicles with the N52 engine are fitted with A/C compressors with magnetic clutches. Vehicles with the N62 engine will initially be equipped with clutchless A/C compressors but will change to clutches later in production. This is implemented as a CO₂ emission reduction measure.

Compressor Drive Pullies

Magnetic Clutch

The magnetic clutch provides the drive connection between the compressor and the engine while the engine is running.

The clutch design consists of:

- Pulley with bearing
- Spring plate with hub
- Solenoid coil

The hub of the spring plate is securely mounted on the compressor drive shaft.

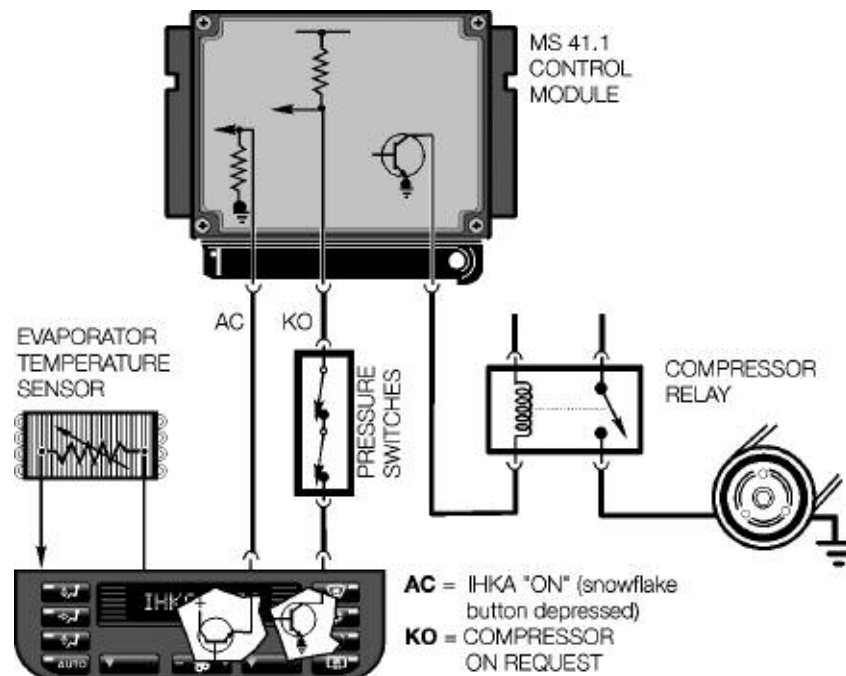
The pulley is mounted on the outer race of the compressor drive shaft bearing.

The solenoid coil is connected to the compressor housing. There is a clearance "A" between the spring plate and pulley.

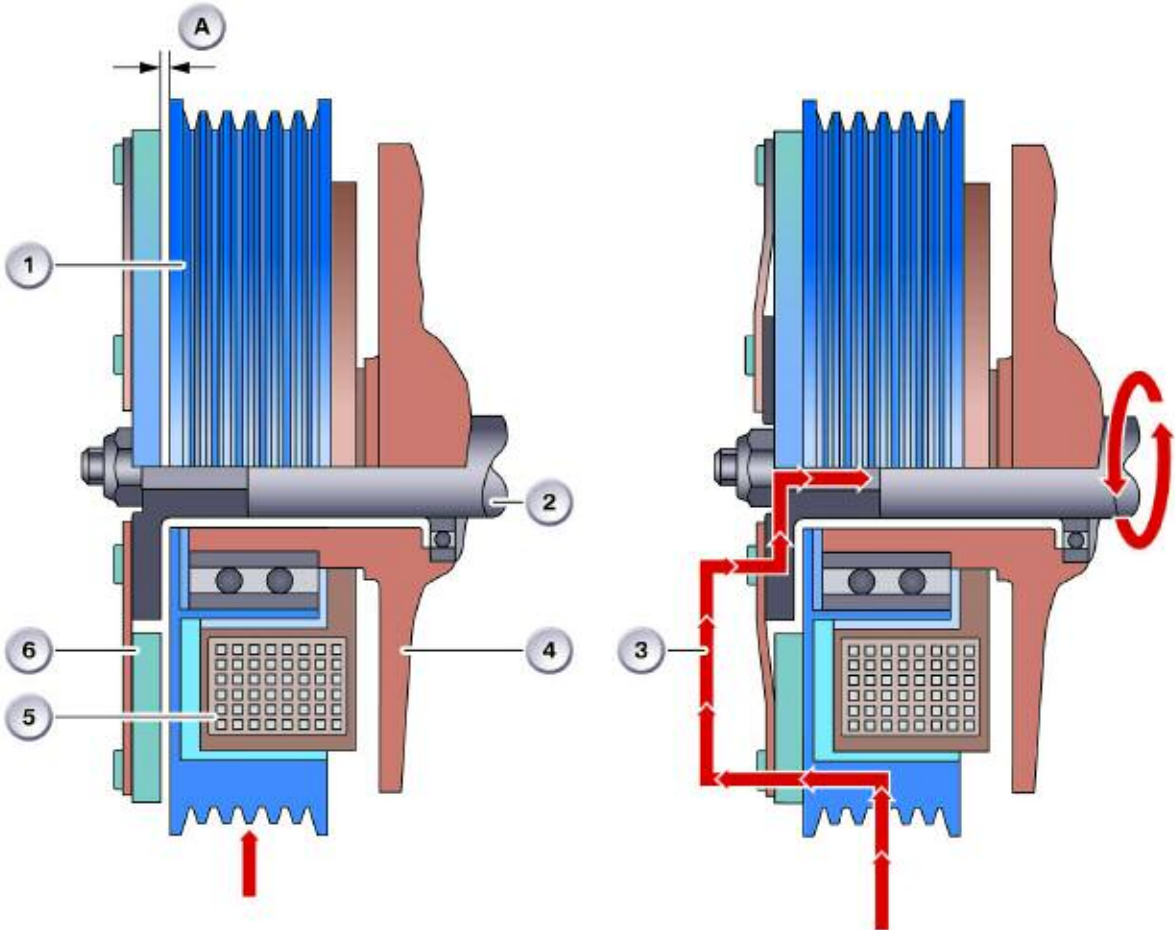
Function

The compressor is driven with the use of a ribbed V-belt riding on the pulley, turned by the engine (arrow). A voltage is applied to the solenoid coil when the A/C is requested. The resulting force from the magnetic field pulls the spring plate against the spinning pulley (bridging the clearance "A"), thus establishing a positive connection between the pulley and drive shaft of the compressor.

The compressor is now running. It continues to operate until the power circuit to the solenoid coil is interrupted. Springs then release the spring plate from the pulley. The pulley runs freely without engaging the compressor shaft.



Magnetic Clutch

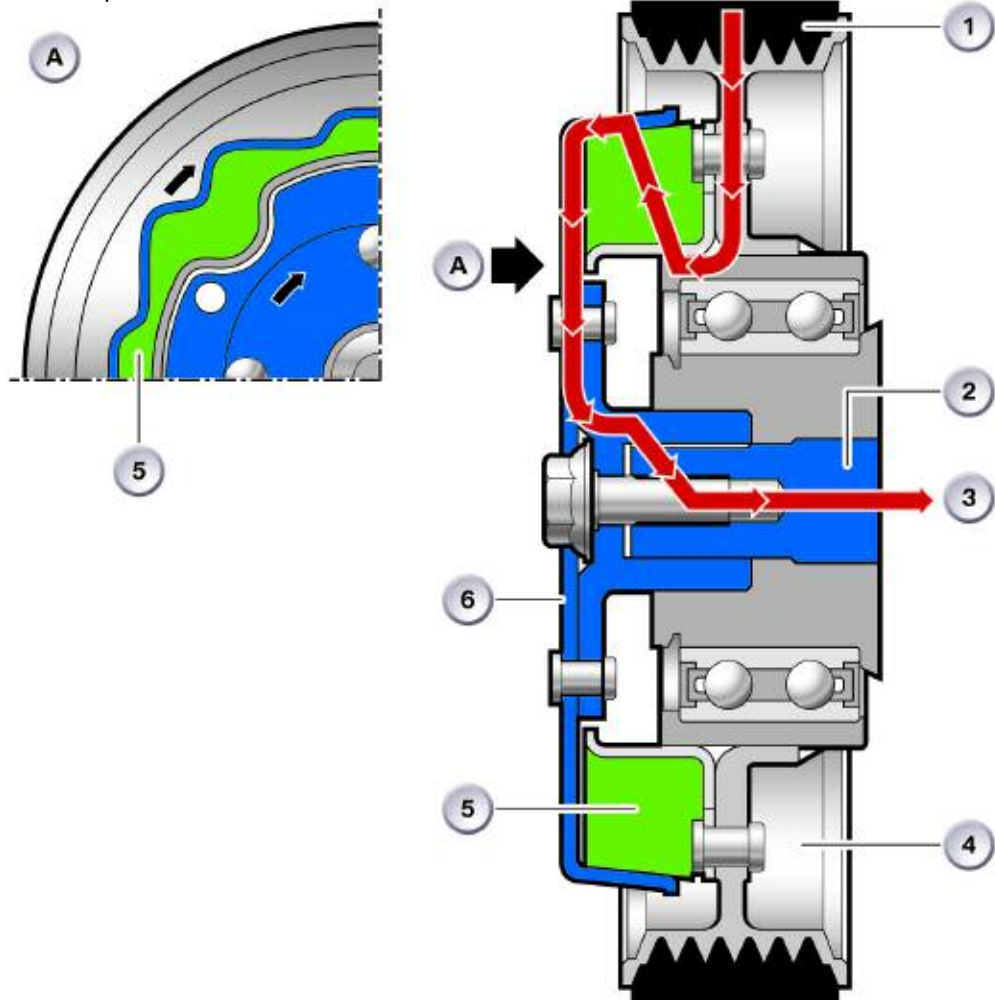


Index	Explanation	Index	Explanation
1	Pulley with bearing	5	Solenoid coil
2	Compressor drive shaft	6	Spring plate with hub
3	Power flow	A	Clearance between spring plate and pulley
4	Compressor housing		

Clutch-Less Pulley

Used as overload protection for compressor in operation; the ribbed V-pulley and the drive plate are positively connected by a rubber formed element. When the compressor is operative, both discs turn together at the same ratio.

Compressor in Operation

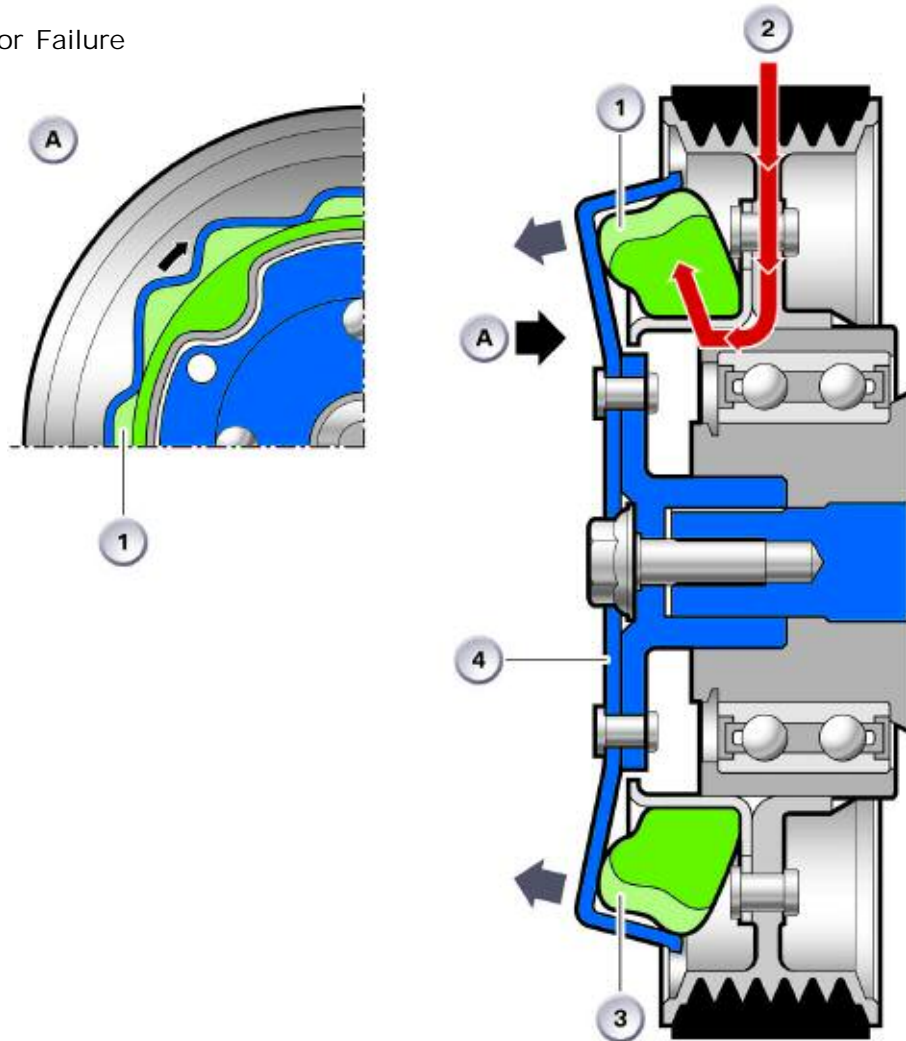


Index	Explanation	Index	Explanation
1	Ribbed V-belt	4	Pulley
2	Compressor shaft	5	Formed rubber element
3	Power flow of a good compressor	6	Drive plate

Function

In the event the compressor ceases and the drive plate stops turning, thus increasing the acting forces between the pulley and the drive plate; the pulley presses on the formed rubber element in the direction of rotation against the locked compressor drive plate. The formed sections of the rubber element are sheared off thus disengaging the connection between the pulley and the drive plate. The pulley now continues to rotate freely. This prevents damage to the ribbed V-belt and therefore to the engine.

Compressor Failure



Index	Explanation	Index	Explanation
1	Sheared material	3	Deformation of formed rubber element
2	Power flow after formed rubber element shears	4	Drive plate locked

Condenser

The condenser is made up of tube coils and fins that are firmly secured to the tubes so as to achieve a large heat exchange area and effective heat transmission.

The task of the condenser is to give off the energy, which the refrigerant has taken up during compression in the compressor, in the form of heat to the outside air via the fins. As a result, the gaseous refrigerant becomes liquid again.

The removal of energy is necessary so that when the refrigerant is injected into the evaporator it can absorb heat energy again from the air to be cooled.

The condenser utilizes the energy difference between the hot refrigerant under pressure and the cooler outside air for the purpose of performing its task.

Function

The procedures in the condenser are divided into three operations.

In the first stage, the hot gaseous refrigerant, at a temperature of approx. 60-120°C coming from the compressor at a pressure of 10 to 25 bar, gives off its superheat to the outside air.

The actual condensation takes place in the second phase where the refrigerant has lost so much energy that it becomes liquid.

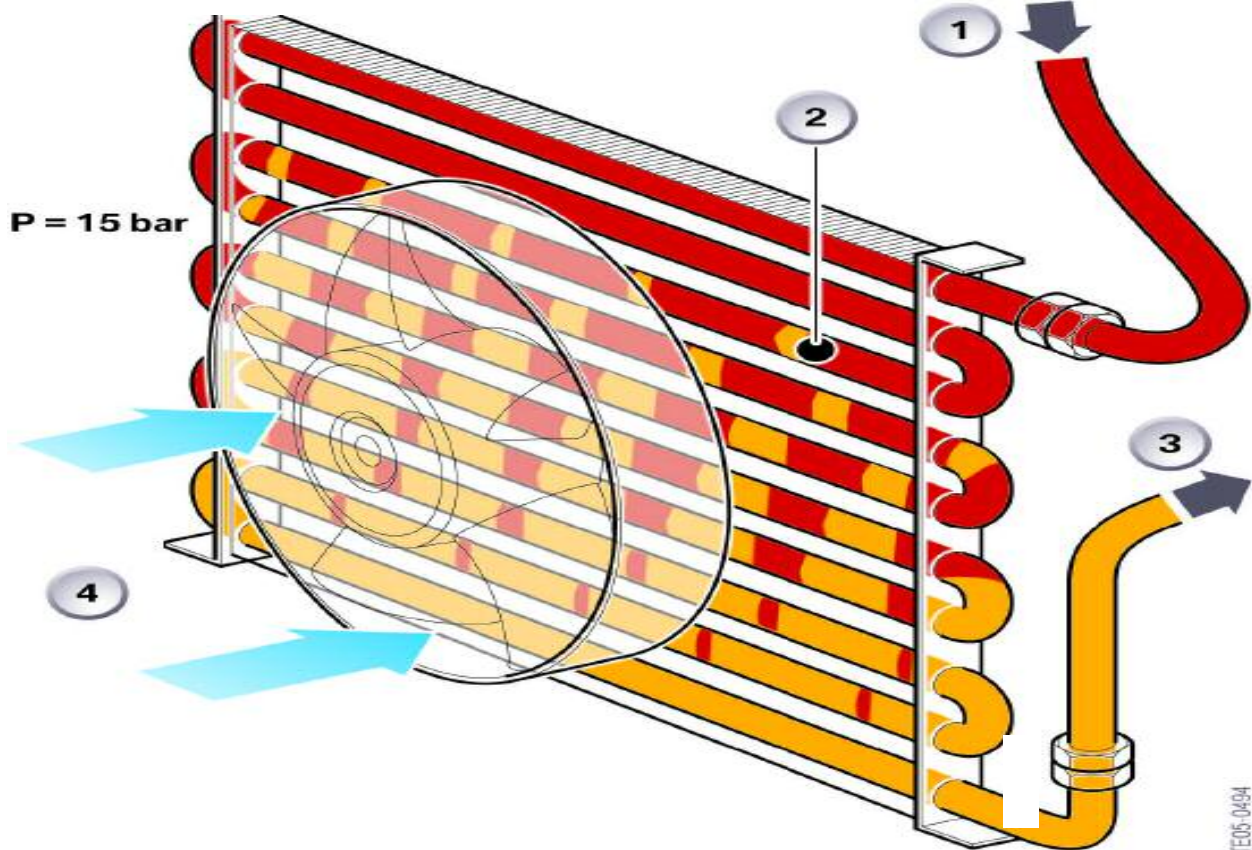
In the third phase, further energy is taken from the now liquid refrigerant. This state is referred to as refrigerant sub-cooling. This phase also makes sure that no gas bubbles can form on the refrigerant's way to the expansion valve. The sub-cooling takes more heat away from the refrigerant than is necessary for actual condensation.

The sub-cooled refrigerant in the evaporator can absorb a larger quantity of heat and thus increase the refrigerating capacity of the system.

The auxiliary fan arranged directly before the condenser ensures an effective supply of cooling air. The refrigerant remains in the condenser at a high pressure of approx. 10-25 bar. Approx. 80-90% of the condenser power is used in the actual condensation process where a temperature drop of 30 to 40°C occur.

Note: The greater the sub-cooling of the refrigerant in the condenser the greater the refrigerating capacity of the air conditioning system.

Condenser



Index	Explanation
1	Refrigerant inlet temperature = +80°C
2	Dew point + 55°C
3	Refrigerant outlet Temperature approx.+45°C
4	Outside air +30°C

Service Information

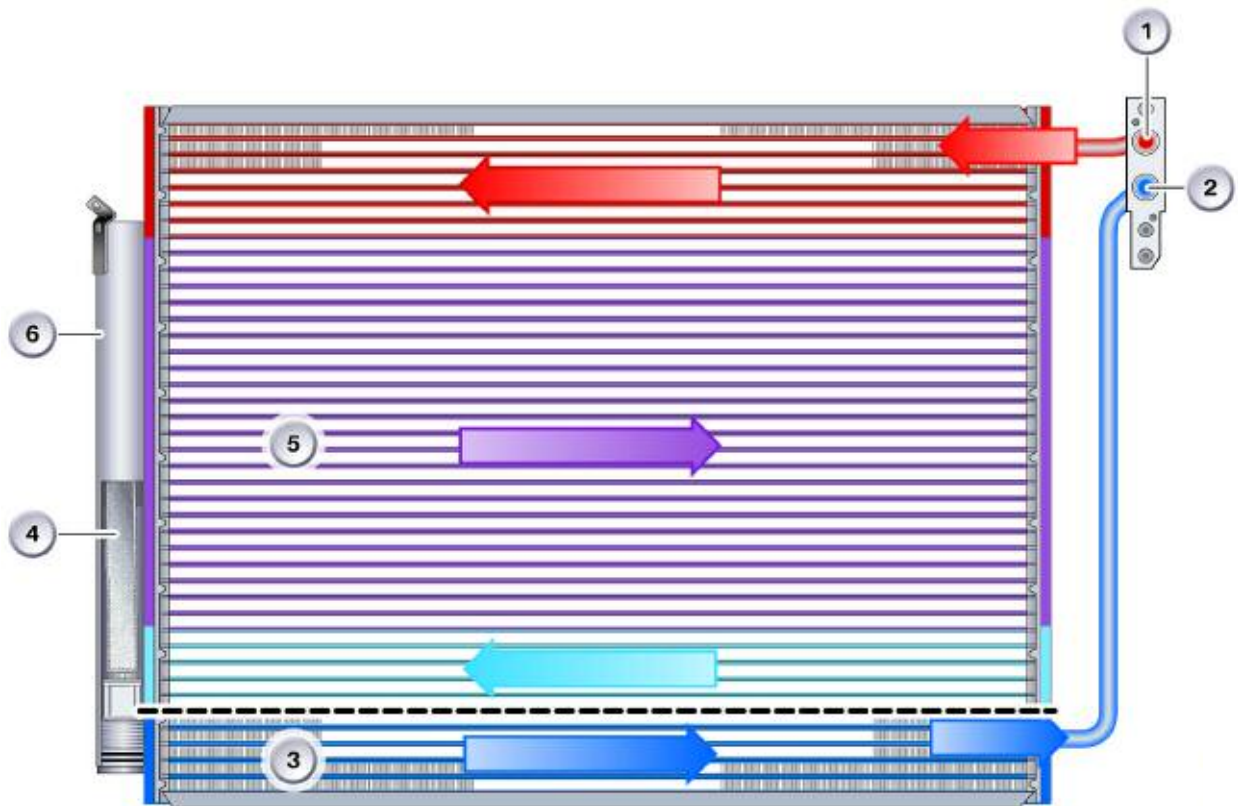
- The distance between the condenser and vehicle radiator must be as large as possible.
- The condenser fins must not be bent or dirty.
- Ensure the auxiliary fan is operating correctly.
- A soiled condenser results in poor condensation and unnecessarily high operating pressures.

Condenser Module

In the past, the high pressure section of the refrigerant circuit was made up of a series of individual components such as the condenser with mounting bracket and connections, separately mounted liquid reservoir with filter and dryer, pressure sensor etc.

As the result of the system integration to form the condenser module with flat tubular condenser, the liquid reservoir (dryer) was mounted on the side of the condenser.

The condenser is divided in two cooling sections. Inside the top 2/3 of the condenser the hot, compressed gaseous refrigerant changes into a liquid as it cools. It enters the receiver dryer through inlet holes located at the lower 1/3 of the condenser cooling area. After passing through the desiccant in the dryer the liquid refrigerant now enters the condenser again and circulates through the lower 1/3 section on its way to the expansion valve. It is now considered a SUB-COOLED liquid.



Index	Explanation	Index	Explanation
1	Hot gas from the compressor	4	Filter dryer
2	Undercooled liquid refrigerant	5	Condenser section
3	SUB-COOLED section	6	Collection reservoir

The condenser module introduced in the E53 features an integrated filter element with woven plastic fabric. A further advantage is the increase in condenser capacity by more effective sub-cooling of the refrigerant. Consequently, the refrigerating capacity remains constant even as the charge volume decreases to 50% of the normal quantity.

The filter/dryer cartridge can be changed by undoing a screw plug. The refrigerant is dried by a bag containing a molecular filter desiccant made from silica gel.

Note: The condenser module with replaceable cartridge dryer element is installed in E53, E6X, E70, and E9X models..



Receiver Dryer

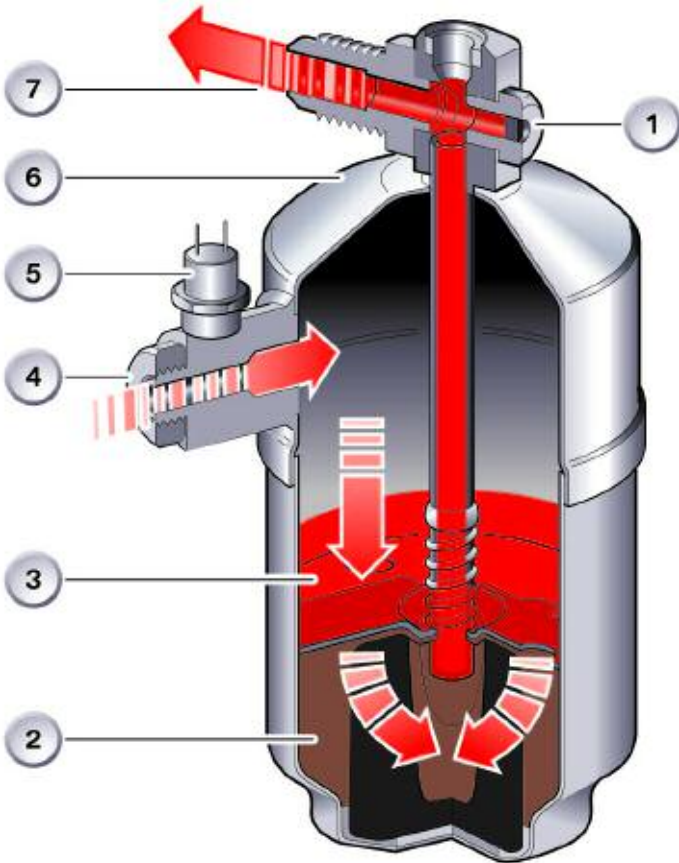
The liquid reservoir serves as an expansion and supply reservoir for the refrigerant. Due to varying operating conditions such as thermal load at the evaporator and condenser as well as the compressor speed, varying quantities of the refrigerant are pumped through the circuit. A liquid reservoir is installed for the purpose of balancing out these fluctuations as it absorbs moisture.

The liquid refrigerant coming from the condenser is collected in the reservoir and only the quantity that is required in the evaporator for cooling the air flows further. The drying agent can chemically bind a small quantity of water thus removing it from the circuit.

Depending on the version, the desiccant can absorb 6-12g (0.2-0.4oz) of water. The absorption rate is dependent on the temperature. The absorption rate increases as the temperature decreases. For example, if a dryer is saturated at a temperature of 40°C (104°F), it will expel water again at 60°C (140°F). Debris from the compressor, dirt and similar matter are also filtered out.

Note: On systems that use conventional dryers, these dryers are non-serviceable and must be replaced (E83, E85, E86)

Conventional Type Dryer



Index	Explanation
1	Pressure relief valve (older System)
2	Filter Dryer
3	Screen Filter
4	Connection from condenser
5	Pressure sensor
6	Housing
7	Outlet to expansion valve

Function

The refrigerant enters the liquid reservoir from above and flows downward along the inside of the housing. It must then pass through the filter dryer where moisture is extracted. The refrigerant rises through a plastic screen filter in the dryer and impurities are filtered out.

The filter element can be compared to a sponge which can absorb and bind water. Molecular filters and silica gel bind moisture and in addition moisture activated aluminum oxide is used to bind acid.

The dryer is integrated in the condenser in the new air conditioning systems as installed in the E53, E6X, E70, and E9X models.

It is therefore no longer a separate component (see condenser module).

Service Information

The following points must be observed when working on the liquid reservoir (dryer):

- The dryer bottle or the dryer insert in an operative air conditioning system with no leaks need not be replaced at regular inspection intervals.
- However, the dryer bottle or the dryer element must be replaced in the case of:
 - Contamination of the refrigerant circuit through metal chips (compressor).
 - Leaks in the air conditioning system or loss of refrigerant.
 - The refrigerant circuit being opened for longer than 24 hours, during a repair procedure.
 - Prior to installation, keep the dryer (or dryer element) closed for as long as possible to ensure no moisture is absorbed from the ambient air.

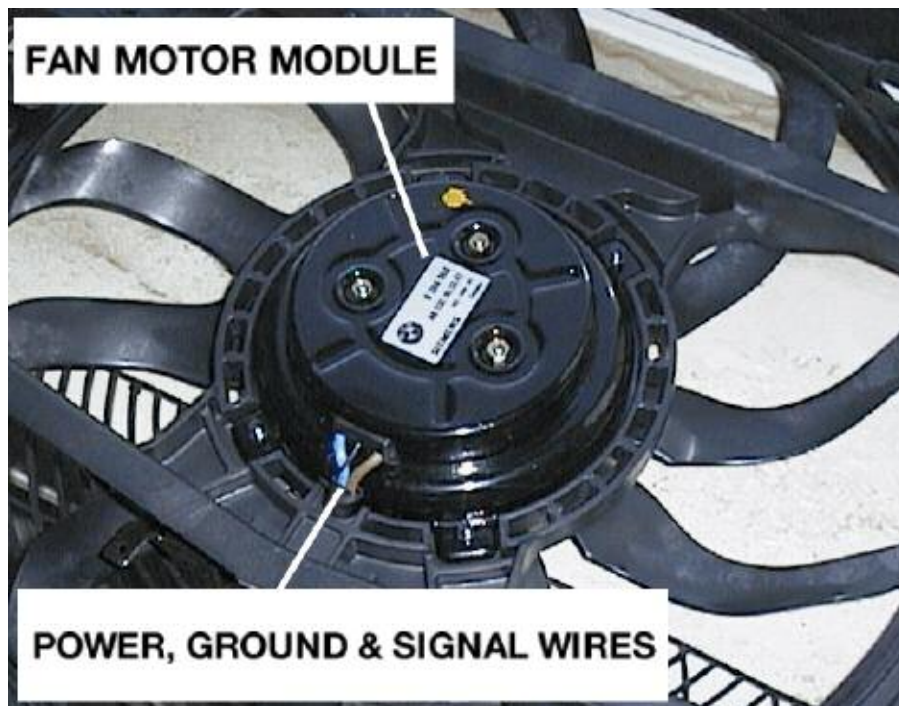
Condenser Fan (Auxiliary Fan)

The auxiliary fan is used to cool the outer surface of the condenser and consequently the hot gaseous refrigerant that flows through it. As the refrigerant cools, it condenses back into liquid state.

The engine management computer communicates with the fan control module which governs the auxiliary fan operation.

The fan is activated based on the following conditions:

- The radiator outlet temperature exceeds a preset temperature.
- The refrigerant pressures reach a predetermined crucial point.
- Vehicle Speed
- Battery Voltage Level



Auxiliary Fan Circuit (Early Models)

The condenser on BMW A/C systems is equipped with an auxiliary fan that provides additional air flow through the radiator and condenser, when needed.

Auxiliary fan control systems vary between vehicles. The following is a typical example of how the auxiliary fan is controlled.

The auxiliary fan is controlled by two normally open relays, a normal speed relay, which runs the fan at the "normal" (low) speed; and a high speed relay which runs the fan at the high speed.

The A/C control module grounds the normal speed relay whenever the A/C system is turned on. This causes the fan to run at normal speed.

The relays are also energized by a (normally open) double temperature switch, which senses coolant temperature in the radiator. When coolant temperature rises above 180°F (82°C), the normal speed half of the switch closes, powering the normal speed relay, and the auxiliary fan runs at normal speed, whether or not the snowflake button is pressed. When the temperature rises above 190°F (88°C), the high speed half of the switch closes, powering the high speed relay, and the auxiliary fan runs at high speed.

There is also an intermediate pressure switch fitted in the receiver/dryer. This switch which is normally open, closes when the refrigerant pressure exceeds 260 psi. This energizes the high speed relay and runs the auxiliary fan at high speed.

Refrigerant Pressure-fan Stage Conversion Table

The pressure sensor receives a 5 volt power supply from the IHKA control unit. The sensor signal is evaluated and forwarded to the DME via the K-Bus. In the process, the refrigerant pressure in the air-conditioning circuit is converted to a load torque and calculation for the required fan speed (stage).

Each fan stage that is determined is transmitted from the ECM to the auxiliary fan output stage. Prerequisite is a speed less than 50 mph.

Note: BMW auxiliary fan operation and strategy varies within vehicles. Refer to the Electrical Troubleshooting Manuals (ETM) for vehicle specific information.

Pressure in bar	Fan stage
8	0
9	1
11	2
13	3
14	4
15	5
16	6
17	7
18	8
19	9
20	10
21	11
22	12
23	13
24	14
>24	15

Thermostatic Expansion Valve (TEV)

The thermostatic expansion valve (TEV) regulates the flow of refrigerant through the evaporator depending on the degree of so called "overheating" of the refrigerant vapor at the evaporator outlet. The amount of refrigerant that can evaporate under the respective operating conditions is fed to the evaporator via the TEV. As one of the separating points between the high-pressure and low-pressure sections, the TEV is installed in the refrigerant circuit ahead of the evaporator.

The flow of refrigerant through the expansion valve is controlled depending on temperature and pressure in order to achieve optimum refrigerating capacity in the evaporator. This metering system ensures the entire heat exchange area is utilized efficiently as pressurized liquid refrigerant expands in the evaporator and absorbs heat from the passenger compartment.

Function

The pressure and temperature are measured by passing the refrigerant through the expansion valve at the outlet of the evaporator. The top section of the TEV measures the temperature of the refrigerant intake and the refrigerant pressure acts on the underside of the diaphragm.

The valve needle is pressed down against a spring to open the valve, allowing liquid refrigerant to flow into the evaporator. The refrigerant evaporates, pressure and temperature drop. The pressure and temperature of the gaseous refrigerant at the evaporator outlet are used to open and close the valve via a diaphragm.

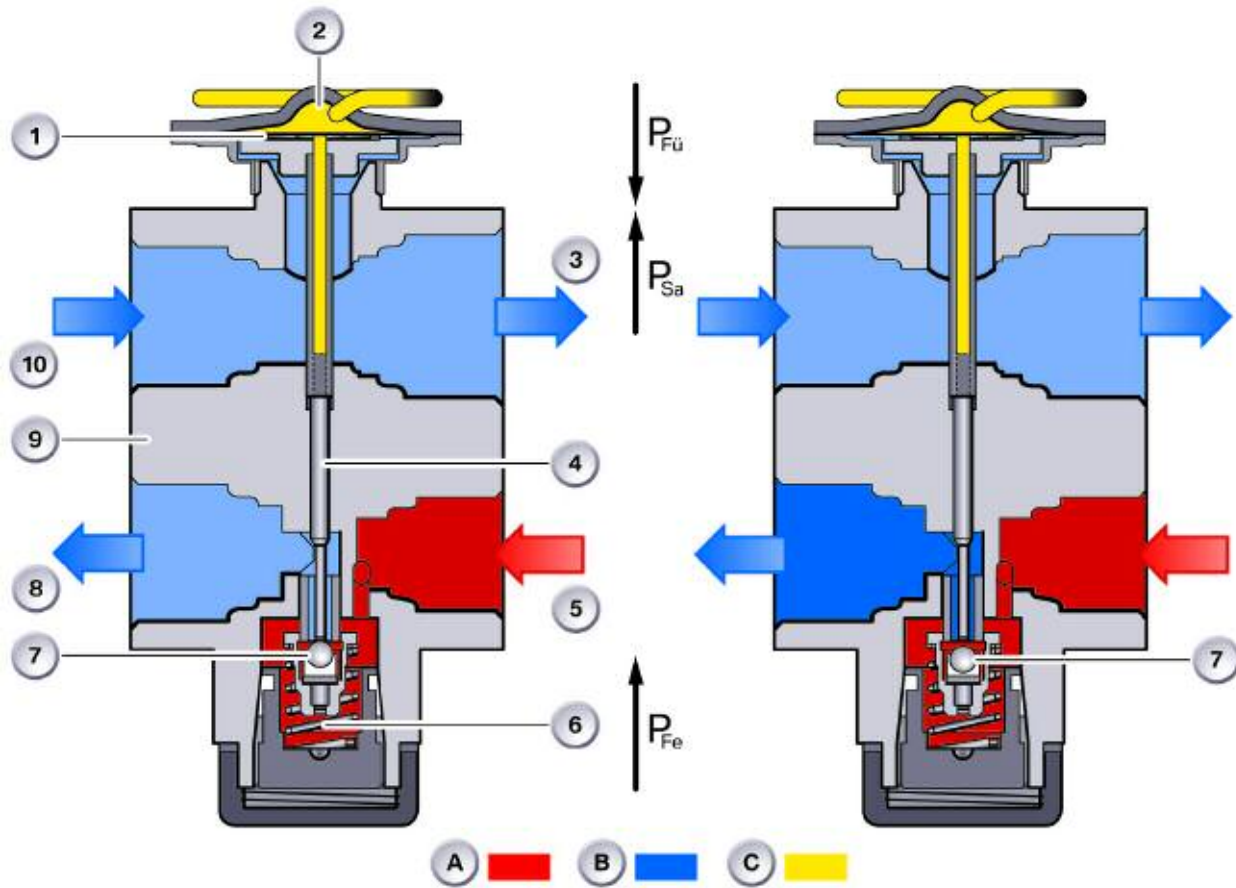
When the air temperature at the evaporator outlet drops, the sensing gas in the diaphragm chamber contracts, this moves the valve needle upward and reduces the coolant flow rate to the evaporator.

The flow rate is increased again when the air temperature at the evaporator output rises. Increasing pressure at the evaporator outlet assists the valve closing action. Decreasing pressure assists the valve opening action. This control procedure runs continuously for as long as the air conditioning system is in operation.

The following points must be observed when working on the expansion valve:

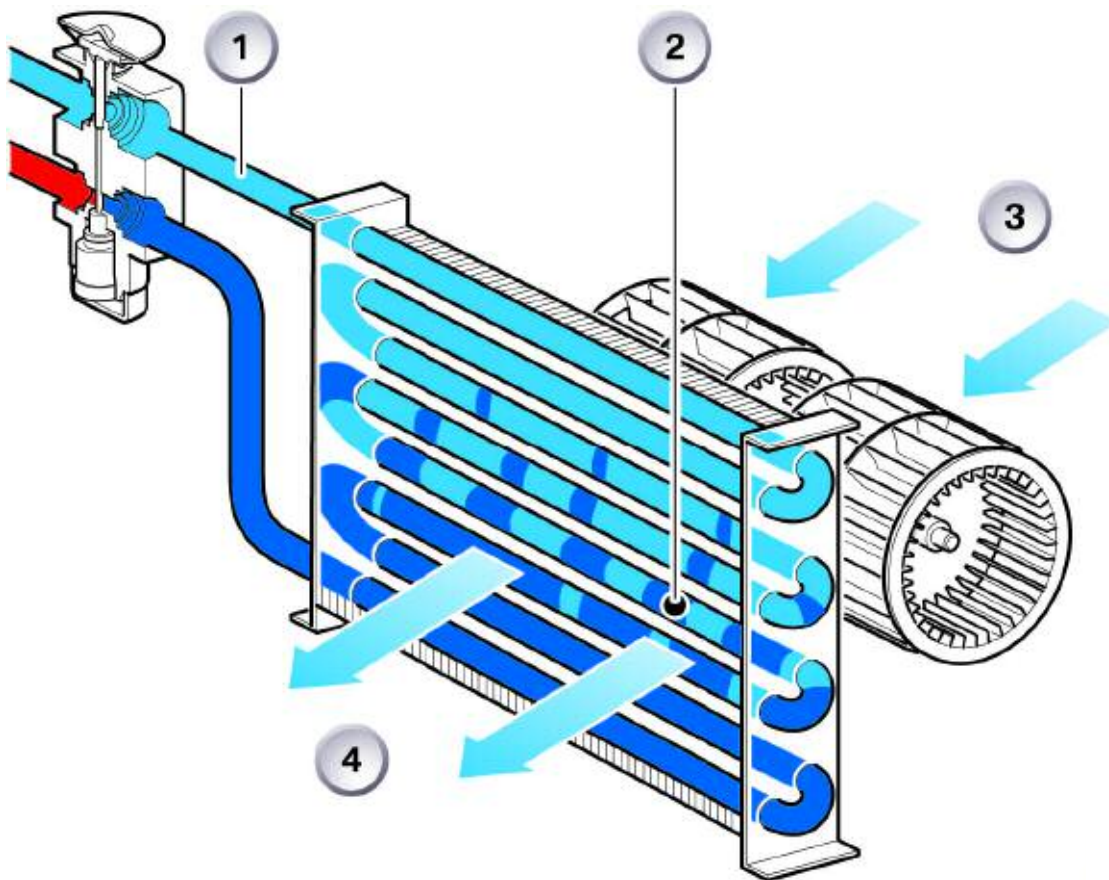
- Very little refrigerant flow through the evaporator will result in poor A/C output.
- If too much refrigerant flows into the evaporator, it will flood and cause possible compressor damage.
- The setting of the expansion valve must not be adjusted or varied (except for instructions in the Service Information).
- The expansion valve must not be repaired.
- Seals must be replaced every time the pipes and hoses are released.

Expansion Valve



Index	Explanation	Index	Explanation
1	Diaphragm	9	Housing
2	Sending gas	10	From evaporator
3	To compressor	A	High pressure
4	Valve needle	B	Low pressure
5	From condenser	C	Sensing gas pressure
6	Spring	P_{Fu}	Pressure in sensor line (sensor fill)
7	Ball	P_{Sa}	Evaporator pressure (low pressure)
8	To evaporator	P_{Fe}	Control spring force

Evaporator



Index	Explanation	Index	Explanation
1	Low pressure Pa 2 bar	3	Air inlet + 30°C
2	Boiling point then -10°C	4	Air outlet +12°C

The evaporator is installed in the housing of the integrated automatic heating and air conditioning system (IHKA) or the integrated heating and air conditioning control (IHKR). It consists of a coiled tube with press-fitted fins. The refrigerant flows through the coiled tube. The blower blows the air to be cooled through the fins. To improve heat transmission, the fins are designed so that they cover a large surface area.

In order to uniformly supply the entire area of the evaporator with liquid refrigerant, the refrigerant is divided into several subsections of equal size after being injected into the evaporator.

This design layout greatly increases the efficiency of the evaporator. The divided refrigerant channels are reunited at the end of the coiled tube where they are drawn in by the compressor.

Like the condenser, the evaporator is also a heat exchanger. It is responsible for the main task of the air conditioning system, extracting heat from the passenger compartment.

A further task of the evaporator is to dry the air by removing moisture. The condensed moisture is expelled to the outside of the vehicle. Air dried in this way assists in keeping the windscreen and windows free of condensation.

Function

The evaporator functions as a heat exchanger in that thermal energy is taken externally from the air and given off internally to the refrigerant. The most important factor is the energy absorption by the refrigerant during the transition from the liquid to the gaseous state. This transition requires a great deal of energy in the form of heat which is taken from the air blown through the system of fins. The refrigerant is evaporated at low pressure and by the heat delivered from the passenger compartment by the use of a blower fan. The refrigerant cools down greatly while the injection procedure ensures the pressure drops from 10-20 bar to approx. 2 bar.

Service Information

The following points must be observed when working on the evaporator:

- The evaporator fins must not be dirty or bent. This would result in the growth of bacteria and odor.
- The evaporator fins must not ice up. If the evaporator does ice up, the fault will be in the area of the evaporator temperature sensor. This situation would result in compressor damage following a longer period of operation of the air conditioning system.
- The micro filter change intervals must be maintained to insure adequate air flow.
- The condensation water drain must not be clogged and water must drain off freely.
- The evaporator temperature sensor must be installed correctly.

Note: To treat bacteria and odor complaints, a special cleaning and treatment procedures must be followed. SI 64 04 03 "A/C System Musty Odor" can be found in TIS.

Hoses and Pipes

The system of hoses and pipes serves the purpose of establishing the connection between the individual components of the air conditioning system. The connections are sealed with O-rings.

The hoses and pipes consist of various materials, different shapes and sizes. A fold, flange or threaded connection is provided at the end of each line.

To date, vehicle air conditioning systems were equipped with flexible hose lines. More recently, aluminum pipes and combinations of aluminum pipes and hose lines have also been used for space-saving purposes.

The hose material is an elastomer formed from various rubber layers. The inside is compatible with the refrigerant and the refrigerator oil.

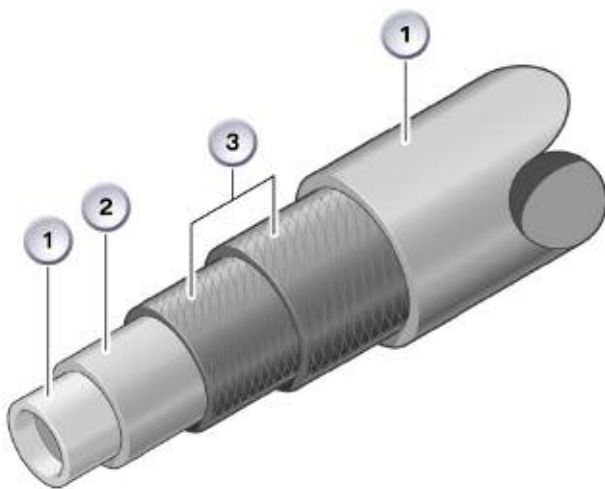
The outside is compatible with weather influences, oils, fuels and other substances used in the vehicle.

In addition, these rubber layers must also be impermeable to the refrigerant and the refrigerator oil of the compressor (from the inside) and to moisture (from the outside).

The refrigerant R134a has smaller molecules than R12 and could therefore more easily penetrate the rubber layers of the hoses.

Thanks to the use of an additional nylon sheathing and a maximum of two inner reinforcements made from woven textile, hose lines are now available that are suitable for use in R134a air conditioning systems.

Hose Material Composition



Index	Explanation
1	Elastomer
2	Nylon sheathing from woven textile
3	Double reinforcement